1. Introduction

Climate change represents one of the most widespread and pressing environmental concern of our time. The detection of significant changes in the Earth's climate over the last 100 years, and the attribution of these changes to anthropogenic (man made) emissions of greenhouse gases (GHGs), has now been accepted by the vast majority of the world's scientists. The main reasons include a century and a half of industrialization, the burning of ever-greater quantities of oil, gasoline and coal, cutting of forests leading to unexpected climate changes, Ozone Layer depletion, Global warming, loss of bio diversity, Threatening to food security, increase in sea level etc.

The Clean Development Mechanism (CDM) is one of the flexible of the Kyoto Protocol. Under the CDM , an industrialised country with a Greeen House Gas reduction target can invest in projects in developing countries , and claim credit for the emission that the project achieves.

Chemical Fertilizers have played a vital role in the success of India's Green revolution. Since the scope of increasing the cultivated land is minimal, increasing the yield is the best way to meet the demand of population and Fertilizer industry has an important role in this area. So the growth of Fertiliser industry in an environmental friendly manner is a must for the overall development of the country.

The rapid growth in the world population has imposed increasing pressure on the quantum of food needs of society. Since the scope of increasing the arable land is minimal, increasing the yield per hectare is the only way to meet the food demands of a growing population and the Fertilizer industry has to step in and play a key role for the benefit of society. Considering the total fertilizer production, India is positioned third in the world and for fertilizer consumption, India is second in the world.

This study analyzes the CDM projects registered under Indian Fertilizer industry. Primary technical data is collected from the CDM project data base of UNFCCC, different

stakeholders like industry, consultant, DoE etc. Attending workshops and seminars , official websites of UNFCCC, cdmindia, and other major players of CDM activity were also contributed considerably in the data collection part. CDM opportunities in the fertilizer application and agriculture front are not coming under the scope of this paper .

2. Objectives

- To make an in depth study on the concept of for Clean Development Mechanism (CDM) .
- To identify the scope / potential of CDM projects in different segments of Indian Fertilizer industry
- Analysing the reasons for the comparatively low success rate of CDM projects in Fertiliser field.
- Making suggestions for improvement of CDM
- Suggestions for post 2012 scenario

3. Research Methodology

The study is based on analysis of primary and secondary Data

Primary data required for this study is taken from the CDM project data base of UNFCCC.

Industry specific data are collected based on formal/informal discussions from selected fertilizer companies like

- The Fertilizers And Chemicals Travancore Limited , Kochi, Kerala
- Rashtriya Chemicals and fertilizers, Mumbai
- Madras Fertilizers limited, Chennai

Data on the role of consultants are collected from consultancy organizations like

- FEDO
- Ecosecurities
- Deloitte Ltd

Data on the role of DOEs (Designated Operating Entity) are collected from

- DNV
- BVQI

Secondary data required for the study is collected from

- 'Fertilizer statistics' published by Fertilizer Association of India
- Indian Journal of Fertilizers
- Annual reports of department of Fertilizers
- Official website of Department of Fertilizers
- Annual reports of Fertilizer Companies
- UNFCCC website
- CDM INDIA web site
- IPCC reports & web site of Indianfertilizer.com
- Technical papers / Books in related area.

4. Procedure for Data collection

Primary data

The researcher collected all the registered CDM projects in India till 2012 Dec CDM project data base of UNFCCC and from that database, 30 Fertiliser industry related CDM projects were short listed. Project Design Documents of all these 30 CDM projects were collected and analysed.

- The researcher visited selected Fertiliser Companies and conduct interviews with senior executives with the support of an unstructured questionnaire.
- Representatives of the Consultancy organizations and DOEs were interviewed personally or telephonically to collect qualitative data.

Secondary data

- Fertilizer statistics and Indian Journal of Fertilizers are made available from Fertilizer Association of India.
- Annual reports are made available from fertilizer Companies FACT, RCF & MFL
- Annual reports of Department of Fertilizers is downloaded from ministry site.
- Technical data on CDM activities and statistics are made available from web sites of UNFCCC, IPCC, CDM India, MOEF , Indianfertilizer.com etc..

5. Brief survey of Earlier works

CDM is also called a Kyoto surprise (Grubb, 1999) as it combines a countries emission reduction obligations to project/ industry emission reductions. Although Latin American countries were the first to set up the Designated National Authorities (DNAs), China and India have emerged as the two most significant participants in the CDM by ratifying the Kyoto Protocol in 2002. India dominated the initial implementation of CDM in early years, but China took a clear lead in the number of projects and Certified Emission Reducrtions in the following years of the first assessment period. An assessment of the Clean Development Mechanism in India was done by Joseph B. Gonsalves (2006) indicating the major areas of focus as energy sector followed by the agricultural and industrial sectors. Projects in renewable energy, industrial efficiency, fuel switching and solid waste disposal were the potential areas planned for CDM.

From a policy perspective, eventhough CDM has a voluntary angle, importance for adequate incentives for both developed and developing countries for the success of CDM (Fischer 2005) was established earlier. There are views that applicability of CDM to the ongoing projects provides subsidies to atleast some projects, that would have happened (Haya 2007). During the initial years of CDM, predominance of hydrofluorocarbon projects, which cost comparatively low investments but receive extraordinarily large credits has led to a market distortion Wara (2007). (In its 32nd meeting in June 2007, the CDM Executive Board referred the consideration of implications of establishing new HFC 23 projects to the Subsidiary Body for Scientific and Technological Advice (CDM Rulebook)). Study by Purohit, Mechaelowa (2007,2008,2009) were focusing on renewable energy sector covering solar, small hydel, bagasse and biomass based CDM projects in India.

On the cost - benefit side, PWC (2000) defines transaction costs of CDM projects as the costs that accrue to project developers from the tasks to be performed in the CDM project cycle. In this study, transaction cost is defined as the sum of costs for the tasks performed in the project cycle, for the full crediting period and the cost required for the search and negotiation activities involved. These transaction costs are borne by the project supplier/seller or investors.

In principle, the CDM provides potential contributions to sustainable development. Technology Transfer by CDM Projects were analysed by Dechezleprêtre, A. et al. (2009) comparing the leading implementers China, India, Brazil, and Mexico.

Fertilizer industry's manufacturing processes and associated environmental issues were deliberated in detail in the technical report of UNEP in collaboration with International Fertilisers Association (UNEP 1998) . Fertiliser production has been increasing steadily from 1960 and the industry have made considerable progress in reducing emissions. Encouraging the adoption of the most effective practices as regards environmental protection by the fertilizer industry is very important for sustainable development.

6. Overview of the research

- Classification of the Fertiliser Industry - on the basis of feed stock / product type
- In depth study on the eligibility criteria and project cycle for Clean Development Mechanism (CDM) - Literature survey / data collection
- Technological details on different products / processes in Fertiliser Industry.
- Assessing the scope / potential of CDM projects in different segments of Fertilizer industry.
- Analysing the factors influencing the success rate of CDM projects.
- Economic aspects of different CDM options.
- Suggstions for post 2012 scenario

7. Findings

1. GHGs associated with Fertiliser Industry are Carbon Dioxide (CO2), Nitrous Oxide (N2O) and Methane (CH4)
2. Major sources of GHG generation in Fertiliser industry are CO2 and N2O from manufacturing process, CO2 from associated power generation, Raw Material and product handling, Methane from Effluent Treatment etc.
3. Factors influencing success rate of CDM projects in fertilizer Industry include comparatively long duration of Project activities, Uncertainty about the post 2012

scenario on projects, Intricacy in defining clear boundary lines in fertilizer industry as most of the intermediate plants are interlinked etc.

4. Economic aspects of fertilizer CDM projects like N2O abatement projects the most successful type during the first commitment period, PDD costs increasing with project complexity etc.

With the completion of the first commitment period and uncertainties regarding the follow up plan, CDM market is unsteady at present. A clear decision regarding the second commitment period from 2013 to 2018 and its follow up action plan is required to improve the situation.

8. Scope for further research

Adaptation of the CDM concept in the post 2012 scenario, where the follow up plan for CDM is yet to be finalized, is to be studied in detail. The market prices of CERs are low now and the forward transaction agreements from the previous period are getting certain consideration. Gold Standard CER, specially focusing in renewable energy and energy efficiency improvement and Voluntary Emission Reductions are the areas having some response now.

There is an increasing number of governments (local, national and regional) intend to utilize market-based policies to address greenhouse gas emissions. In addition to the established emissions trading systems in Europe, New Zealand, and regions in the United States of America, systems are emerging in Australia, Canada, China, Kazakhstan and South Korea. Crediting programmes are also emerging, including bilateral mechanisms between developed and developing countries as well as a range of offset protocols. In India, the Perform, Achieve and Trade (PAT)scheme being implemented under the National Action Plan for Climate change, by the Government of India is giving special focus on energy efficiency improvement in industrial sector. By 2015 energy assessment under PAT scheme will be operational and this has a good scope for detailed study.

9. Conclusions

It is important for all industries to keep CO2 emissions as low as possible, and the fertilizer industry contribute to this through technological progress. Specific energy consumption in the production of all major fertilizers has been declining due to employing superior processes and switching over to cleaner feed stocks and fuel.

CDM has opened an opportunity for improving the environmental friendliness of the fertilizer industry during pre 2012 period.

There is scope for CDM projects in fertilizer industry and there were 30 CDM projects registered by fertilizer companies in India during the first assessment period, with a total annual Certified emission reduction of 2.9 Million CERs.

Energy efficiency improvement, N_2O abatement and Fuel / feedstock change are the major areas for CDM projects in Indian fertilizer industry. With the completion of the first commitment period and uncertainties regarding the follow up plan, CDM market is unsteady at present. A clear decision regarding the second commitment period from 2013 to 2018 and its follow up action plan is required to improve the situation.

10. List of publications

1. K.Jayachandran & Dr G.Madhu., "An analysis of the CDM projects in Indian Fertiliser Industry", International Journal of Civil, Structural, Environmental and Infrastructural Engineering Research and Development (ISSN (P):2249-6866; ISSN(E): 2249-7978, August 2014.
2. K.Jayachandran & A Asokan, "Indian Fertilizer Industry - Problems and Prospects", Chemical Industry Digest (ISSN-0971-5266) annual, January 2010.
3. K.Jayachandran "Energy efficiency improvement - a major CDM project opportunity in Fertiliser industry", National Journal Science & Society (ISSN 0973-0206), May 2011